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EXAMINER
ARTMAN, THOMAS R

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/769,859	Applicant(s) GROOT ET AL
	Examiner Thomas R Artman	Art Unit 2882

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 January 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-80* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-48,60-63 and 65-80* is/are rejected.

7)☒ Claim(s) *3, 49-59 and 64* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *4* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Objections

Claim 3 is objected to because of the following informalities: it appears as though the "first surface" and "first datum surface" should be the "second" of each, corresponding to the interferometric profiling of the second surface. The claim will be examined upon those merits.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-8, 12, 16, 27-34, 36, 38, 40, 42 and 74-75 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bruning (US 5,654,798).

Regarding claims 1, 40 and 42, Bruning teaches of a grazing angle interferometric profilometry method and apparatus (Fig.8), including:

1) interferometrically profiling a first surface of the test object with respect to a first datum surface (item 120),

2) interferometrically profiling a second surface of the test object with respect to a second datum surface (item 122),

3) providing a spatial relationship between the first and second datum surfaces, and

4) calculating a geometric property based on the interferometrically profiled surfaces and the spatial relationship between the first and second surfaces.

Bruning teaches, at least in col.7, that the spatial relationships between the datum surfaces are crucial to the operation of the interferometer. It would have been obvious to one of ordinary skill in the art at the time the invention was made that the interferometer is inherently basing the calculated geometric property in part upon the spatial relationship of the datum surfaces. The optical path difference is caused by the separation of the partially reflecting first datum surface and the reflecting second datum surface, and the angles greatly affect the resolution of the interferometer.

Regarding claims 2 and 3, Bruning provides distances between measured points on the first and second surfaces to the first and second datum surfaces, respectively.

Regarding claim 4, the first datum surface is a portion of a plane.

Regarding claim 5, Bruning discloses an alternative embodiment where one of the datum surfaces is curved (Fig.9, item 148).

Regarding claim 6, at least one of Bruning's datum surfaces has a structured profile (see Fig.5).

Regarding claims 7 and 8, the first and second surfaces are spaced from one another, and, in fact, are opposite surfaces of the test object.

Regarding claim 12, the interferometric profiling step comprises directing EM radiation along first and second directions to the first and second surfaces, respectively.

Regarding claim 16, Bruning's datum surfaces have a defined relationship (see, by way of example, col.7). The relative angles and distances are necessarily controlled for proper functioning and optimum precision of the device.

Regarding claims 27-33, Bruning's grazing angle profilometer can measure flatness, thickness, parallelism, step height, angular orientation, perpendicularity and roundness (see, by way of example, col.10, lines 10-23, as well as interference patterns in the figures).

Regarding claim 34, Bruning's profilometer determines the geometric property in part upon getting the measurements from a plurality of points on both surfaces into a common coordinate system.

Regarding claim 36, Bruning's profilometer is a scanning interferometer (by linearly translating the first datum surface along the optical axis, col.4, lines 2-5). Bruning does not specifically state the use of IR radiation, but it does state that the light is coherent. It would have been obvious to one of ordinary skill in the art at the time the invention was made that IR wavelengths are almost exclusively used in optical interferometry systems where long coherence lengths are desired.

Regarding claim 38, Bruning's profilometer performs scanning, grazing-incidence interferometry.

Regarding claims 74-75, Bruning's device can handle partially transparent test objects, and measurements of many points are taken on both sides of the object.

Claims 9, 32 and 39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bruning and in view of Kulawiec (US 5,793,488).

Regarding claims 9 and 32, though Bruning's device is shown to measure only parallel surfaces, it can be inferred from col.10, lines 10-23 that modifications can be made in order to accurately profile more complex geometries.

Kulawiec teaches a modification that can be made whereby the first and second surfaces of the test object are adjacent and are measured for their angular relationship, which is a representation of perpendicularity as shown in Figs.6A-C.

It would have been obvious to one of ordinary skill in the art at the time the invention was made that the structure and method provided by Kulawiec is advantageous and accepted by Bruning's teachings to be a functional equivalent modification for the increased flexibility of an interferometer to analyze complex surfaces.

Regarding claim 39, though Bruning does not disclose the use of multiple wavelength interferometry, Kulawiec discloses that an alternative to phase shifting is to use multiple wavelength interferometry by changing the wavelength of the illumination light (col.6, lines 11-15).

It would have been obvious to one of ordinary skill in the art at the time the invention was made that the use of multiple wavelength interferometry as taught by Kulawiec is a known functional equivalent modification of the method taught by Bruning.

Claims 1, 13-15, 17-26, 40-43, 60-63, 66 and 72-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kulawiec.

Regarding claims 1, 40, 42 and 72-73, Kulawiec teaches the structure and method of:

1) interferometrically profiling a first surface of a test object with respect to a first datum surface,

2) interferometrically profiling a second surface of a test object with respect to a second datum surface different from the first,

3) providing a spatial relationship between the datum surfaces, and

4) calculating a geometric property based on the interferometrically profiled surfaces and the spatial relationship between the datum surfaces.

In col.4, lines 53-59, Kulawiec teaches a movable stage that is advantageously moved such that measurements can be made at several different positions in order to calculate and remove systematic errors. Each of these positions is a datum level for each set of measurements of multiple points on each surface. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to take measurements at various positions in order to remove systematic errors, and thus improve the accuracy and precision of the measurement device.

Further regarding claim 73 and regarding claim 66, as stated in the previous paragraph, the use of multiple datum positions is for reducing systematic errors, which one skilled in the art would recognize that PCOR is a type of systematic error, or error that is caused by an artifact of the measurement system.

Regarding claims 13-14, 43 and 60, as stated in col.4, lines 53-59, there is a movable stage that defines at least a first and second datum surface with respect to which multiple measurements are made and then compared by a computing unit in order to remove systematic errors.

Regarding claim 15, it would have been obvious to one of ordinary skill in the art at the time the invention was made that moving the test object or moving a component of the interferometry system are functional equivalent modifications of each other, with no real advantage or disadvantage to one method over the other.

Regarding claims 17-26, 41, and 61-63, it would have been obvious to one of ordinary skill in the art at the time the invention was made to take interferometric measurements with a "gage block," "reference object," or an "initialization surface," etc.

Whether the device is a cutting tool, stylus profilometer, interferometric profilometer, etc., all such devices are calibrated by measuring an object, appropriate in size to the dimensional order of magnitudes in which the device operates, where the object has at least one known (calibrated) dimension. Part of the calibration step is to find the zero point, or datum position, from which dimensional measurements can be accurately taken. Even Kulawiec must calibrate the movable stage using a reference object such that the computing unit accurately knows the position of the object under test for measurements taken at each datum position.

Therefore, as broadly as claimed, there is no patentable distinction over what a person with even elementary skill in the art would know or be able to accomplish without the benefit of the applicant's disclosure.

Claims 65 and 67-71 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kulawiec and in view of Mackinouchi (US 5,969,800).

Regarding claim 65, Kulawiec does not disclose the use of a displacement interferometer for measuring the position of the spatial relationship between the first and second datum surfaces of the movable stage.

Mackinouchi discloses an exemplary interferometric displacement system for measuring the precise position of a stage. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use such a device since there can be more precise, fast control of the stage for quick, accurate measurements.

Regarding claim 67, Kulawiec discloses an interferometric profiler, including:

1) interferometrically profiling a first surface of a test object with respect to a first datum surface,

2) interferometrically profiling a second surface of a test object with respect to a second datum surface different from the first,

3) providing a spatial relationship between the datum surfaces, and

4) calculating a geometric property based on the interferometrically profiled surfaces and the spatial relationship between the datum surfaces.

In col.4, lines 53-59, Kulawiec teaches a movable stage that is advantageously moved such that measurements can be made at several different positions in order to calculate and remove systematic errors. Each of these positions is a datum level for each set of measurements of multiple points on each surface. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to take measurements at various positions in order to remove systematic errors, and thus improve the accuracy and precision of the measurement device.

Kulawiec does not state the use of an interferometric profilometer for measuring the position of the stage.

Mackinouchi discloses an exemplary interferometric displacement system for measuring the precise position of a stage. It would have been obvious to one of ordinary skill in the art at the time the invention was made to use such a device since there can be more precise, fast control of the stage for quick, accurate measurements.

Regarding claim 68, Mackinouchi discloses an additional stage and interferometer for measuring it's position and the first stage's position for more accurate profilometry.

Regarding claim 69, as stated in col.4, lines 53-59 of Kulawiec, there is a movable stage that defines at least a first and second datum surface with respect to which multiple measurements are made and then compared by a computing unit in order to remove systematic errors.

Regarding claim 70, Mackinouchi's displacement interferometers are multi-axial.

Regarding claim 71, Kulawiec's profilometer is a scanning interferometer (by linearly translating the first datum surface along the optical axis, col.6, lines 10-23). Kulawiec does not specifically state the use of IR radiation, but he does disclose that the light is coherent. It would have been obvious to one of ordinary skill in the art at the time the invention was made that IR wavelengths are almost exclusively used in optical interferometry systems where long coherence lengths are desired.

Claims 1, 10-11, 35, 37, 40, 42 and 76-80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Johnson (US 6,392,752).

Regarding claims 1, 40 and 42, Johnson teaches a while light interferometric profilometer that performs the function of:

1) interferometrically profiling a first surface of a test object with respect to a first datum surface (item BS1 of Fig.2),

2) interferometrically profiling a second surface of a test object with respect to a second datum surface (item BS3) different from the first datum surface,

3) providing a spatial relationship between the datum surfaces, and

4) calculating a geometric property based on the interferometrically profiled surfaces and the spatial relationship between the first and second datum surfaces.

Regarding claim 10, the test surfaces are separated by a step height (the surfaces are shown flat for simplified illustration purposes).

Regarding claim 11, the test surfaces are generally separated by a distance greater than a range of the interferometer (coherence length), hence the need for separate datum surfaces when performing white light interferometry.

Regarding claim 35, Johnson's interferometric profilometer is a white light interferometer.

Regarding claim 37, it would have been obvious to one of ordinary skill in the art at the time the invention was made that Johnson's device performs MESA.

Regarding claim 44, Johnson discloses a first viewing port (item L1) and a second viewing port (item L3) for viewing the first and second surfaces, respectively.

Regarding claim 45, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use separate cameras. This is often used for quadrature measurements, which are known in the art for gleaning larger amounts of data from the interferometric data.

Regarding claim 46, Johnson's camera images all view ports.

Regarding claim 47, what interferometric profilometer doesn't have at least one EM radiation source?

Regarding claim 48, Johnson provides optics to direct the light from the test surfaces to the viewing ports.

Regarding claim 76, the first and second surfaces of the test object are interferometrically profiled from a common side. Also, the datum surfaces are out of range of the focal length of the light with respect to each other. Though this may not be

apparent by the figures, there are many steps in the microlens array, and the difference from the first to last datum surfaces is farther than the coherence length. As taught by Johnson, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have this relationship such that varying step heights can be measured.

Regarding claims 77 and 78, the arguments made about calibration in the rejections against at least claim 17 stand here. Any measurement system requires an appropriate reference object with known dimensions as part of standard calibration procedures.

Regarding claims 79-80, Johnson teaches in his white-light interferometric profilometer:

1) a broadband source,

2) a scanning interferometer which directs a first wavefront along a reference path including a partially reflective first surface (item BS1) and a reflective second surface (item M1), and a second wavefront along a measurement path contacting a measurement object (item 106), and after the second wavefront contacts the measurement object, combines the wavefronts to produce an optical interference pattern,

3) a detector producing interference data in response to the optical interference pattern,

4) an electronic processor coupled to the detector for analyzing the interference data, and

5) a scanning controller coupled to the scanning interferometer and the electronic processor, wherein during operation the scanning controller causes the scanning interferometer to adjust the position of the first and second surfaces.

Though his device is not shown as a scanning interferometer, Johnson teaches in col.4, lines 21-23, that either BS1 or M1 could be scanned, as is known in the art with Mirau interferometers.

Regarding claim 80, the first surface of the scanning interferometer defines a first datum surface and the second surface defines a second datum surface, and wherein a geometric property of the test object is calculated based on the interference data and a relationship between the first and second datum surfaces.

Allowable Subject Matter

Claims 49-59 and 64 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Regarding claim 49, the prior art made of record does not disclose or reasonably teach the arrangement of directing a beam in a third direction for interferometric measurement of a test object.

Claims 50-56 are dependent upon claim 49.

Regarding claim 57, the prior art made of record does not disclose or reasonably teach the use of a second interferometric profilometer to measure a second surface of a test object.

Claims 58-59 are dependent upon claim 57.

Regarding claim 64, the prior art made of record does not disclose or reasonably teach the use of a reference object during the measurement of a test object.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Muller (US 6,271,925) discloses a grazing angle interferometer.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thomas R Artman whose telephone number is (703) 305-0203. The examiner can normally be reached on 8am - 5:30pm Monday - Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Robert Kim can be reached on (703) 305-3492. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-1782.

DAVID V BRUCE
PRIMARY EXAMINER

Thomas R. Artman
Patent Examiner
May 2, 2003